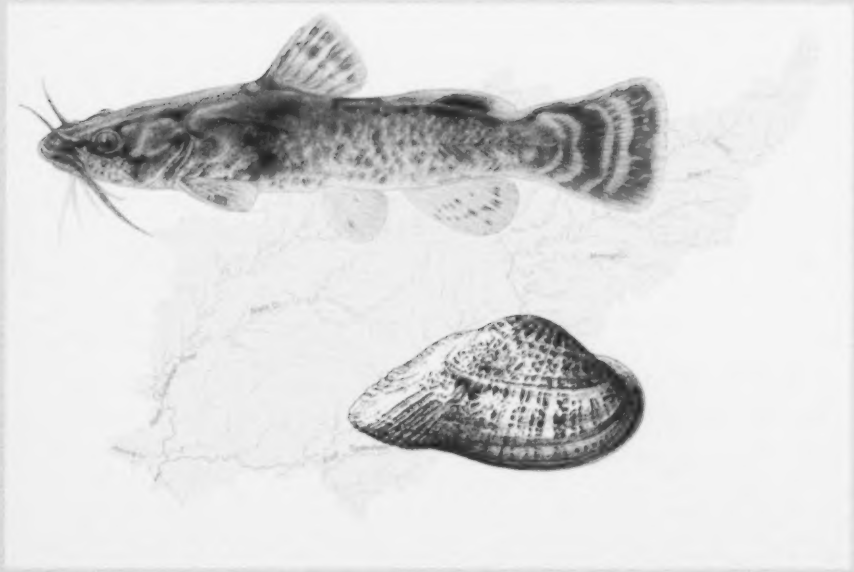
Species at Risk Act
Action Plan Series

Action Plan for the Sydenham River in Canada: An Ecosystem Approach

Freshwater Mussels: Northern Riffleshell, Snuffbox, Rayed Bean, Salamander Mussel, Round Pigtoe, Kidneyshell and Round Hickorynut

Fishes: Eastern Sand Darter – Ontario population and Northern Madtom



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For copies of the action plan, or for additional information on species at risk, including COSEWIC Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the SAR Public Registry.

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Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996) agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA) the federal competent ministers are responsible for the preparation of action plans for species listed as Extirpated, Endangered, and Threatened for which recovery has been deemed feasible. They are also required to report on progress five years after publication of the final document on the SAR public registry.

Under SARA, an action plan provides the detailed recovery planning that supports the strategic direction set out in the recovery strategy for the species. The plan outlines what needs to be done to achieve the population and distribution objectives (previously referred to as recovery goals and objectives) identified in the recovery strategy, including the measures to be taken to address the threats and monitor the recovery of the species, as well as the measures to protect critical habitat that has been identified for the species. The action plan also includes an evaluation of the socio-economic costs of the action plan and the benefits to be derived from its implementation. The action plan is considered one in a series of documents that are linked and should be taken into consideration together. Those being the COSEWIC status report, the recovery strategy, and one or more action plans.

The Minister of Fisheries and Oceans Canada is the competent minister under SARA for the seven freshwater mussels (Round Hickorynut, Kidneyshell, Northern Riffleshell, Snuffbox, Round Pigtoe, Rayed Bean and Salamander Mussel) and two fishes (Eastern Sand Darter – Ontario population and Northern Madtom) and has prepared this ecosystem-based action plan to implement the applicable recovery strategies, as per section 47 of SARA. To the extent possible, it has been prepared in cooperation with the Government of Ontario, St. Clair Region Conservation Authority, University of Guelph and University of Michigan.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions and actions set out in this action plan and will not be achieved by Fisheries and Oceans Canada, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this action plan for the Sydenham River to benefit the seven freshwater mussels and two fishes and Canadian society as a whole.

Implementation of this action plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

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Executive summary

The Sydenham River in southwestern Ontario supports an amazing diversity of aquatic life. Located in the lower Great Lakes basin, the river contains the greatest diversity of freshwater mussel species of any watershed in Canada. At least 34 species of mussels and 80 species of fishes have been found here. Many of these species are rare and seventeen species, including eleven mussels and six fishes, have been assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Endangered, Threatened or Special Concern. The majority of these species are protected under the federal *Species at Risk Act* (SARA) and seven freshwater mussels (Round Hickorynut, Kidneyshell, Northern Riffleshell, Snuffbox, Round Pigtoe, Rayed Bean and Salamander Mussel) and two fishes (Eastern Sand Darter – Ontario population and Northern Madtom) are the focus of this action plan. The needs of these at risk fishes and mussels within the Sydenham River watershed will be addressed using a multi-species, ecosystem-based approach. The present plan is guided by four SARA recovery strategies for these nine species and builds on the ecosystem-based Sydenham River Recovery Strategy completed in 2003.

The Sydenham River watershed is highly agricultural and dominated by row cropping with less than 15% wetland and forest habitat remaining. The river has two main branches – the North Sydenham and the East Sydenham, the latter of which provides critical habitat for eight of the nine species at risk (the Northern Madtom has not been reported from the river since 1975). Known or suspected threats to these species in the watershed include: siltation, nutrients, toxic contaminants, thermal effects, exotic species and altered flow.

The action plan includes an implementation schedule with 25 prioritized measures to support the recovery of the target fish and mussel species at risk. Where possible, multi-species approaches are recommended. The recovery measures include: research and monitoring (7 actions), management (4 actions); stewardship and habitat improvement (10 actions); and, outreach and awareness (4 actions). To maximize the effectiveness of threat mitigation, stewardship actions have been directed within the five priority sub-basins (conservation priority zone) of the East Sydenham River. Best Management Practices in these regions will address the following: loadings of nutrients and suspended solids from overland runoff and livestock; nutrient loads from municipal sewage; ammonia from overland runoff of manure; and thermal effects from loss of riparian buffers in agricultural and urban catchments.

An evaluation of the socio-economic costs and benefits of the action plan are included; costs are anticipated to be low with the majority of funds for implementation being provided by various levels of government. Many 'on the ground' actions are voluntary and would provide benefits to both agricultural and non-farm land owners. Secondary benefits of implementing the action plan would include improved water quality as well as improved habitats supporting enhanced fisheries and wildlife.

Methods for measuring and reporting on progress of implementation are also included.

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1. Introduction

The Sydenham River in southwestern Ontario (Figure 1) supports an amazing diversity of aquatic life. The river contains the greatest diversity of freshwater mussel species of any watershed in Canada. At least 34 species of mussels and 80 species of fishes have been found here. Many of these species are rare and seventeen species, including eleven mussels and six fishes, have been assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Endangered, Threatened or Special Concern (Table 1); in addition, the Sydenham River also supports numerous other semi-aquatic species at risk including turtles and dragonflies. The majority of these species are protected under the federal *Species at Risk Act* (SARA) and/or the Ontario *Endangered Species Act*, 2007 (ESA).

Some of these species, such as Rayed Bean, occur in only one other location in Canada and persist in only a few locations in North America. The Salamander Mussel is found nowhere else in Canada and is considered globally vulnerable. The Northern Riffleshell population in the Sydenham River is one of only three remaining relatively healthy and reproducing populations globally. Consequently, the Sydenham River is of global significance to the conservation of these species.

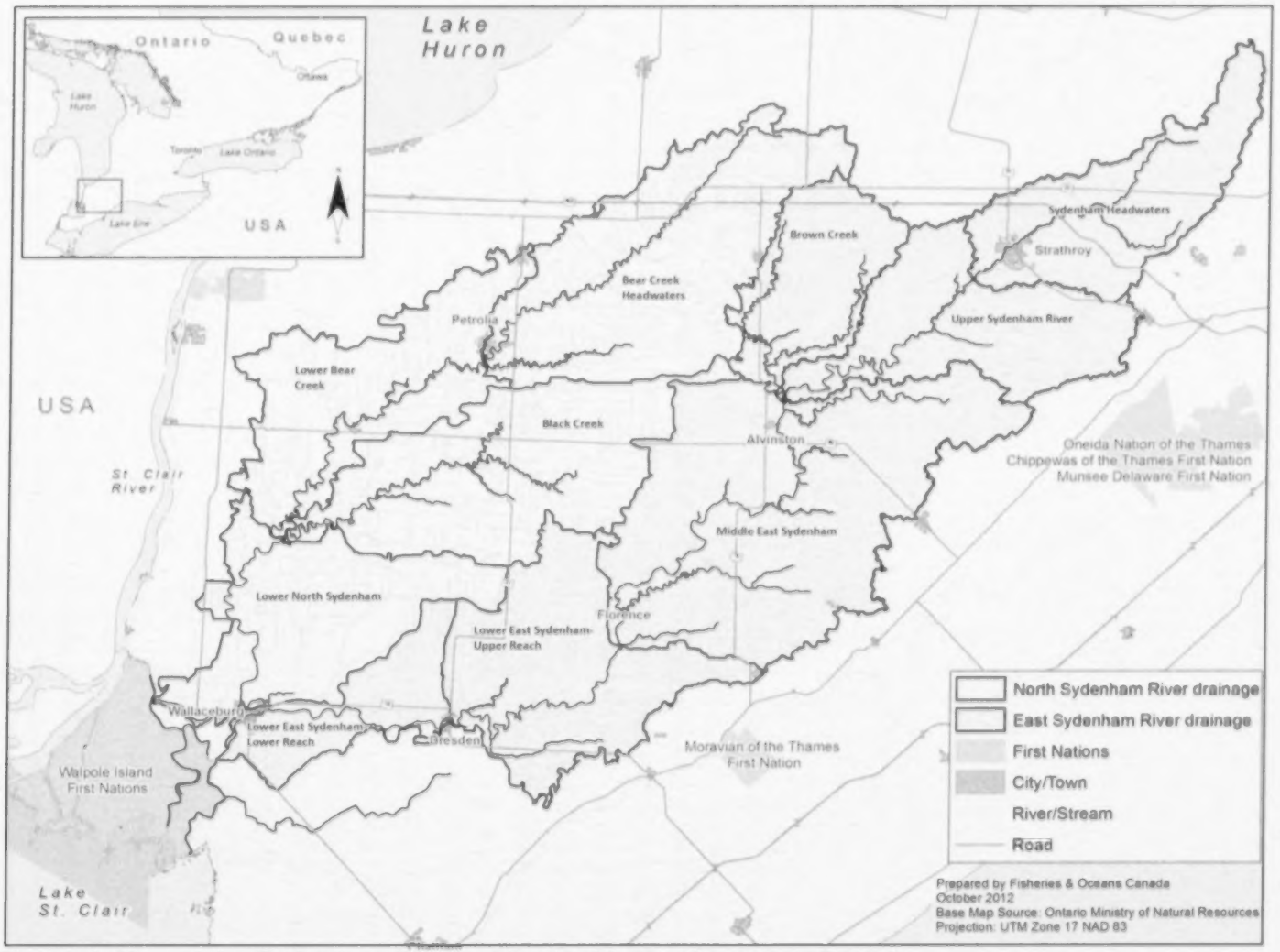

Figure 1. Map of the Sydenham River watershed in southwestern Ontario.

Table 1. Aquatic Species at Risk found in the Sydenham River watershed.

Common Name	Species	COSEWIC Status	SARA Status	ESA Status
FRESHWATER MUSSELS				
Fawnsfoot	*Truncilla donaciformis*	Endangered	Under consideration	Endangered
Kidneyshell	*Ptychobranchus fasciolaris*	Endangered	Endangered	Endangered
Mapleleaf (Great Lakes-St. Lawrence population)	*Quadrula quadrula*	Threatened	Threatened	Threatened
Northern Riffleshell	*Epioblasma torulosa rangiana*	Endangered	Endangered	Endangered
Rainbow Mussel	*Villosa iris*	Special Concern	Endangered*	Threatened
Rayed Bean	*Villosa fabalis*	Endangered	Endangered	Endangered
Round Hickorynut	*Obovaria subrotunda*	Endangered	Endangered	Endangered
Round Pigtoe	*Pleurobema sintoxia*	Endangered	Endangered	Endangered
Salamander Mussel	*Simpsonaias ambigua*	Endangered	Endangered	Endangered
Snuffbox	*Epioblasma triquetra*	Endangered	Endangered	Endangered
Wavy-rayed Lampmussel	*Lampsilis fasciola*	Special Concern	Special Concern	Threatened
FISHES				
Blackstripe Topminnow	*Fundulus notatus*	Special Concern	Special Concern	Special Concern
Eastern Sand Darter (Ontario population)	*Ammocrypta pellucida*	Threatened	Threatened	Endangered
Grass Pickerel	*Esox americanus vermiculatus*	Special Concern	Special Concern	Special Concern
Northern Madtom	*Noturus stigmosus*	Endangered	Endangered	Endangered
Pugnose Minnow	*Opsopoeodus emiliae*	Threatened	Special Concern*	Special Concern
Spotted Sucker	*Minytrema melanops*	Special Concern	Special Concern	Special Concern

* SARA status under review due to change in COSEWIC status.

To ensure the continued survival of these and other aquatic species at risk, the Sydenham River Recovery Team was formed in 1999 and developed a national, ecosystem-based recovery strategy for this globally significant watershed (Dextrase *et al.* 2003). The ecosystem approach used recognizes the links between species, communities and the land and water base that support them. The intention is to maintain or enhance the natural aquatic communities in the Sydenham River watershed through managing the impacts of human activities on land and waters in the watershed. Dextrase *et al.* (2003) identified the following benefits of an ecosystem approach:

- recovery actions are selected that benefit several target species at risk
- implementation is generally more cost-effective than a single-species approach
- addresses issues of scale (from site-specific to watershed level)
- it targets mitigation and rehabilitation of impacts, and it restores ecosystem health to prevent the decline of other native species

- ensures that actions taken to benefit some species will not negatively impact other species at risk in the area

The recovery team prepared four background reports and a synthesis report on the Sydenham watershed and the associated species at risk. The team recognized that planning and implementation of watershed-based activities requires the full involvement and support of landowners and stakeholders in the watershed. The recovery team included landowners in their membership, and held community meetings and information sessions with stakeholders in the watershed. Recovery efforts have included extensive stewardship projects, management actions, community awareness and outreach activities as well as research and monitoring. Implementation of these efforts was further guided through the completion of four Recovery Action Plans in 2003, prior to the enactment of SARA. Most of the accomplishments of this recovery work have been detailed in the five year reports for two recovery strategies: *Report on the Progress of Recovery Strategy Implementation for the Round Hickorynut (Obovaria subrotunda) and Kidneyshell (Ptychobranchus fasciolaris) in Canada for the Period 2006-2011* (2013b) and *Report on the Progress of Recovery Strategy Implementation for the Wavyrayed Lampmussel, Northern Riffleshell, Snuffbox, Round Pigtoe, Mudpuppy Mussel and Rayed Bean in Canada for the period 2006-2011* (DFO 2013c). The present initiative will build on this foundation of recovery work and further advance restoration of the Sydenham River ecosystem.

2. Scope of the action plan

Action plans are prepared for species that are listed under SARA as Endangered or Threatened and already have completed recovery strategies in place. As such, this action plan addresses the needs of seven freshwater mussels and two fishes found within the Sydenham River watershed that are listed under SARA as Endangered or Threatened (Table 2); these species have recently updated recovery strategies with critical habitat identified to the extent possible within the Sydenham River and throughout their range. This action plan should be considered along with the four applicable recovery strategies (references found in Table 2); these recovery strategies provide the strategic direction and approaches for recovery of these mussels and fishes throughout their range and provide background information on the species and their threats. These species co-occur within the same habitats and share similar threats within this watershed, thus supporting an ecosystem or watershed-based approach to recovery implementation. As such, the focus of this action plan will be on targeted habitat improvement and stewardship as well as priority research and monitoring specific to the watershed.

Table 2. Aquatic Species at Risk addressed by the Sydenham River Action Plan.

Species	SARA Status	Recovery Strategy
Kidneyshell	Endangered	*Recovery Strategy for the Round Hickorynut (Obovaria subrotunda) and the Kidneyshell (Ptychobranchus fasciolaris) in Canada* (DFO 2013a)
Round Hickorynut	Endangered	
Northern Riffleshell	Endangered	*Recovery Strategy for Northern Riffleshell, Snuffbox, Round Pigtoe, Salamander Mussel and Rayed Bean* (DFO 2018)
Rayed Bean	Endangered	
Round Pigtoe	Endangered	
Salamander Mussel[1]	Endangered	
Snuffbox	Endangered	
Eastern Sand Darter (ON population)	Threatened	*Recovery Strategy for the Eastern Sand Darter (Ammocrypta pellucida) in Canada: Ontario populations* (DFO 2012)
Northern Madtom	Endangered	*Recovery Strategy for the Northern Madtom (Noturus stigmosus)* in Canada (Edwards *et al.* 2012)

This action plan will seek to support the population and distribution objectives for these nine species – that is to return/maintain self-sustaining populations within the Sydenham River watershed. These species would be considered to have met their population and distribution objectives within the watershed when they have returned to historically estimated ranges and/or population densities and have demonstrated active reproduction and recruitment.

Although not specifically addressed by this action plan, the other eight at risk mussels and fishes found within the Sydenham River (Table 1) will benefit from the recovery actions proposed for the nine priority species (Table 2) through overall improvement to shared aquatic habitats. Note that the Wavyrayed Lampmussel has not been collected from the Sydenham River in recent years and is now considered extirpated from the watershed (Morris 2006). Where SARA management plans exist for Special Concern fishes (i.e., Blackstripe Topminnow, Pugnose Minnow, Spotted Sucker [Edwards and Staton 2009] and Grass Pickerel [Beauchamp *et al.* 2012]), this action plan will support many of the management actions required for these species. Other semi-aquatic species at risk (e.g., turtles and dragonflies) are also expected to benefit from this plan but are not specifically addressed.

This action plan has been organized in seven parts. The following section relates to background information describing the watershed and the current population status of the SARA-listed Endangered or Threatened aquatic species. The fourth section summarizes the perceived threats to ecosystem recovery. The fifth section relates to recovery actions and includes details on implementation and critical habitat. The sixth section provides a socio-economic evaluation of the action plan and the last section deals with measuring progress.

[1] Previously referred to as the Mudpuppy Mussel

3. Background

3.1 Sydenham River watershed

The following background information has been summarized and updated from Dextrase *et al.* (2003). The Sydenham River is a large river system that drains 2725 km^2 of southwestern Ontario into Lake St. Clair. The river has two main branches: the North Sydenham and the East Sydenham, with the confluence located in Wallaceburg. The smaller north branch has two main tributaries, Bear Creek and Black Creek, and drains an area of 617 km^2. The longer East Sydenham River arises from the Lucan moraine near Ilderton and has no large tributaries. About 5 km south of Wallaceburg, the main stem of the river empties into Chenal Ecarte, a channel on the low-lying shore of Lake St. Clair.

The entire Sydenham River watershed is of low relief, with low stream gradients and shallow valleys. Land use throughout the basin is predominantly agricultural, and the human population is small (74 000), with concentrations in the towns of Strathroy, Petrolia and Wallaceburg. The watershed was historically covered by 70% forest and 30% swamp, but agriculture now covers about 85% of the watershed and is dominated by row cropping. Poor natural drainage has resulted in the construction of extensive tile drainage and open drain networks. Tile drainage now accounts for over 60% of the total land area of the watershed and wetlands have been reduced to <1% of the total surface area.

The Sydenham River is a basic, hardwater aquatic environment that is currently nutrient enriched and turbid. The high levels of turbidity and nutrients (particularly phosphorus) are presumably due principally to runoff from farmland. In particular, tile drains facilitate the movement of suspended solids and nutrients from farmland into the river and may significantly contribute to turbidity and nutrient loading. Discharges from sewage treatment plants may also contribute significantly to nutrient loading, while erosion caused by cattle access to the river or tributaries, low-level crossings, channelization, and narrow bridge spans are also considered to be significant contributors to sediment loading.

Substrate in the watershed varies between the East and North Sydenham rivers. The East Sydenham River has a relatively diverse substrate and associated habitat with well-defined riffles and pools, which create exceptional habitat for native freshwater mussels (including seven species listed under SARA as Endangered). Habitat in the North Sydenham River is not as diverse and generally has poorly developed channel morphology with few riffles. Any riffles that are present tend to be of poor quality, consisting of tightly packed gravel or small cobbles embedded in clay that do not support endangered mussel species. For the purposes of this action plan, the Sydenham River watershed has been divided into ten sub-watersheds (Figure 1).

3.2 Species at risk populations

The current population status and distribution of the Endangered and Threatened species at risk in the Sydenham River watershed was most recently summarized by DFO (2012; 2013a; 2018) and Edwards *et al.* (2012) and is provided in Table 3. For freshwater mussels, Metcalfe-Smith *et al.* (2007) was consulted for the most recent recruitment and density data to assist in determining sub-basin population status. The eight extant species are concentrated in three sub-watersheds of the East Sydenham River, with their population status ranging from poor throughout their current distribution (Salamander Mussel, Round Hickorynut, Round Pigtoe and Eastern Sand Darter) to fair in some sub-basins (Kidneyshell, Northern Riffleshell, Snuffbox and Rayed Bean); the Rayed Bean is the only species with a population status of 'good' in one or more sub-basins. The Northern Madtom has not been collected in the Sydenham River watershed since 1975 and may be extirpated (Edwards *et al.* 2012). However, additional targeted sampling is recommended in reaches with suitable habitat and it is possible that the species may still persist in lightly sampled regions. If further sampling for the Northern Madtom fails to detect the species, overall improvement of aquatic habitats within the East Sydenham River would benefit the species if re-introduced in the future.

Additional surveys are required for some species to confirm these assertions. Although all known data were used in the analysis, the majority of records are from the past 40 to 50 years and often based on only presence or absence. Recent quantitative data for freshwater mussels is limited to the 15 monitoring stations established in the watershed between 1999 and 2003 (Metcalfe-Smith *et al.* 2007).

Table 3: Species population status and distribution by sub-watershed.

Species	Population Status by Sub-watershed									
	Sydenham Headwaters	Brown Creek	Upper East Sydenham	Middle East Sydenham	Lower East Sydenham - Upper Reach	Lower East Sydenham - Lower Reach	Bear Creek Headwaters	Lower Bear Creek	Black Creek	Lower North Sydenham
Kidneyshell										
Salamander Mussel										
Northern Riffleshell										
Rayed Bean										
Round Hickorynut			EXT?	EXT?						
Round Pigtoe										
Snuffbox										
Eastern Sand Darter										
Northern Madtom				EXT?						

EXT? = Possibly Extirpated

Population Status	Poor	Reproduction status is poor or unknown; population density is unknown or low (only a few individuals/site)
	Fair	Evidence of reproduction (as determined by Metcalfe-Smith *et al.* 2007 for mussels); population density is unknown or low
	Good	Reproduction status is good; population density is moderate (for mussels density exceeds 1/m^2)

3.3 Threats to species at risk

Known or suspected human-induced threats to aquatic species at risk in the Sydenham River were determined through a synthesis of all available background information by Jacques Whitford Environment Ltd. (2001). These threats are summarized in Table 4 with additional information added from recovery strategies for the nine mussels and fish species at risk (Table 2) and include: sediments, nutrients, toxic contaminants, thermal effects, and exotic species. Jacques Whitford Environment Ltd. (2001) used hypotheses of effect approaches to evaluate the causes of each threat (as well as the spatial extent and magnitude of impact) and determine the probable success of mitigation as low, medium or high. This analysis has been summarized in Table 4 for the East and North Sydenham basins. Note that the overall level of concern for each threat takes into account the extent, frequency, causal certainty and severity. The high or medium threats and/or threats with a high rate of probable successful mitigation are:

- Suspended solids from tile drainage and overland runoff associated with agricultural practices and livestock management
- Sedimentation upstream and soil erosion downstream of dams
- Nutrients including phosphorus, nitrate and nitrite from tile drainage, overland runoff and livestock associated with agricultural practices
- Nutrients including phosphorus and nitrite from urban sewage
- Toxic contaminants from overland runoff of herbicides and other pesticides associated with agricultural practices
- Toxic contaminants from overland runoff from manure spills (e.g. ammonia)
- Increased water temperatures due to loss of riparian buffers from agricultural or urban land management
- Exotic species including dreissenid mussels, Common Carp (*Cyprinus carpio*) and Round Gobies (*Neogobius melanostomus*) associated with reservoirs or upstream migration

An overview of each of the predominant threats has been summarized below from Dextrase *et al.* (2003), unless otherwise noted.

Siltation: Loading of suspended solids causing turbidity and siltation is presumed to be the primary limiting factor for most aquatic species at risk in the Sydenham River watershed. The majority of species at risk mussels depend on clean gravel and sand riffles and are particularly vulnerable to siltation. Siltation can bury and smother mussels as well as interfere with feeding and successful reproduction. Fishes such as

the Eastern Sand Darter prefer clean sand substrates and cannot tolerate highly silted habitat conditions (DFO 2012).

Nutrient loads: Phosphorus and nitrogen compounds, primarily from agriculture, are at high levels within the Sydenham River watershed and represent potential risks to aquatic fauna. Nutrients enter the system from multiple sources and long-term water quality monitoring data indicate that much of the nutrient load is bound to suspended solids and thus likely originates from farmland. However, municipal sewage outflows do contribute nutrient loadings, particularly in the East Sydenham River where treatment plants are located near Strathroy, Alvinston, Dresden and Wallaceburg.

Contaminants: Herbicides and insecticides associated with agricultural practices and urban areas run off into the Sydenham River watershed and could have a significant impact on species at risk (DFO 2018). Manure spills also occur and can be acutely toxic to fishes and invertebrates as well as cause significant nutrient-enriching effects. Oil spills from active or abandoned wells have occurred in the watershed in the past and can contribute oil and metals to the aquatic system. Roads and urban areas can also contribute chlorides, oil and grease and heavy metals. The glochidia (larval stage) of freshwater mussels are particularly sensitive to chlorides and levels in the Sydenham River are known to be slowly increasing.

Petroleum products are another source of potential contaminants. At least two petroleum pipelines from Sarnia (200 mm and 300 mm in diameter) undercross the East Sydenham River and/or Bear Creek and some of their tributaries (Ontario Geological Survey 1982). Although the probability of a pipeline failure is low, the expected impact of a spill on freshwater mussels and other aquatic organisms and their habitat could be extensive. In 2010, a large oil spill (from a pipeline that provides bitumen to Sarnia) into a tributary of the Kalamazoo River, Michigan, a catchment of the Great Lakes basin, resulted in extensive impacts to the freshwater community. A post-mortem survey of mussel shells suggested injury to freshwater mussels as a result of exposure to contaminants released during the spill as well as physical injuries to mussels as a result of the response activities, such as crushing by boat traffic, habitat alterations and sedimentation (Badra 2011); at risk mussels were among the species recorded as dead. Two years following the spill, it was estimated that as many as 200 acres of river bottom, mostly sand/gravel which provides excellent mussel habitat, was contaminated with a thick deposit on the benthic zone due to this spill (D. Woolnough, pers. comm., University of Michigan, June 2012).

There is also the recently recognized threat from potential leakages of liquids associated with hydraulic fracturing of natural gas (Environmental Commissioner of Ontario 2012) if the Kettle Point Antrim Shale near Alvinston is drilled (23 000 acres of Lambton and Kent County were already leased for shale gas exploration in 2010). The potential impact of the proprietary liquids used in shale gas extraction on aquatic species is unknown, but would warrant review if hydraulic fracturing of natural gas resources within the East Sydenham River watershed proceeds.

Thermal effects: The loss of riparian zones in agricultural and urban lands increases solar radiation reaching the stream surface. Although there are riparian corridors along the Sydenham River and its tributaries, these vary in width and quality, and there are extensive reaches lacking riparian zones. Reservoirs also increase temperatures by increasing surface area and by water holding. Although the Sydenham River supports a warm-water environment, and many species are tolerant of warm water, higher water temperatures may be an added stress for some.

Exotic species: Dreissenid mussels have decimated native freshwater mussels in many waters of the Great Lakes basin. Although dreissenid mussels occur in the outfall of the Sydenham River, they do not threaten upstream populations of native mussels as much of the river is not navigable by motorized boats and has no significant impoundments that could support a permanent colony. However, the smaller reservoirs at Coldstream and Strathroy in the East Sydenham River headwaters are of some concern. Common Carp, which occur throughout the system, may be significantly increasing turbidity by uprooting plants and feeding on sediment-associated fauna (which may include juvenile mussels). The Round Goby is also expanding its range in the Sydenham River and may pose a direct threat to fish species at risk such as the Eastern Sand Darter (DFO 2012) and an indirect threat to mussel species if host fish populations are affected (DFO 2013a; DFO 2018; Poos *et al.* 2010). Additional introductions of exotic species into these waters are most likely to occur through the movement of boats from infested areas, the use of live baitfish, or the natural invasion of species introduced into the Great Lakes basin.

Altered flow: Fluvial geomorphology work (Parish Geomorphic 2000) concluded that peak flows have been significantly reduced in the Sydenham River and this was attributed to dams and reservoirs. Extreme weather events and channel straightening can also affect mussel habitat through altering flow, resulting in stress or mortality from stranding during low flows or scouring during excessive flows. The effects of climate change are also expected to have a negative impact on river flows over the longer term.

Table 4: Threats to species at risk, causation and probability of successful mitigation (modified from Jacques Whitford Environment Ltd. (2001)).

General Threat	Specific Threat	General Cause	Specific Cause	Overall Level of Concern		Expected Mitigation Success Rate
				East Sydenham	North Sydenham	
Sediments	Suspended Solids	Agriculture	overland runoff	High	High	High
			tile drains	Medium	Medium	Low
			livestock	Low	Low	High
	Erosion/ deposition	Roads		Low	Low	Low
		Bridges, culverts		Low	Low	Medium
	Sedimentation upstream	Dams	reduced flow	High*	High*	Medium
	Erosion downstream	Dams	reduced sediment load	High*	High*	Medium
Nutrients	P, N, NH3	Agriculture	overland runoff	High	High	High
			tile drains	Medium	Medium	Low
			livestock	Low	Low	High
	P, N	Urban	municipal sewage	High	Medium	High
Toxic contaminants	Chlorides	Roads	de-icing	Low	Low	Low
	Metals	Oil wells/ fields	runoff	Low	Medium	Medium
	Petroleum products	Failure of oil field extraction practices, pipeline failure	runoff, leakage/spills	Low	Low	Low/Medium?
	Ammonia, herbicides, pesticides	Agricultural practices, urban areas	overland runoff	Medium	Medium	High
			tile drains	Low	Low	Low
Thermal effects	Increased water temps	Reservoirs	water holding	Low	Low	Medium
		Agriculture	loss of riparian buffer	Low	Low	High
			water taking	Low	Low	Low
		Urban	loss of riparian buffer	Low	Low	High
Exotic species	Dreissenids, Round Goby, Common Carp	Impoundments and upstream migration	Competition for food and habitat, loss of host fish	High	High	Low
Altered flow	Low flow	Climate change		Low	Low	Low
		Water taking		Low	Low	Low
		Impoundments		Low	Low	Low
	Excessive flow	Climate change		Low	Low	Low
		Channel straightening		Low	Low	Low

** relates only to the following 3 sub-basins where dams are present: East Sydenham Headwaters, Upper East Sydenham and Bear Creek Headwaters*

4. Recovery actions

4.1 Critical habitat

4.1.1 Identification of the species' critical habitat

Critical habitat for the seven freshwater mussels and two fishes has been identified to the extent possible within the respective recovery strategies for these species using the best available information: refer to Section 7 of the *Recovery Strategy for the Round Hickorynut (Obovaria subrotunda) and the Kidneyshell (Ptychobranchus fasciolaris) in Canada* (DFO 2013a); Section 2.6 of the *Recovery Strategy for Northern Riffleshell, Snuffbox, Round Pigtoe, Salamander Mussel and Rayed Bean* (DFO 2018); Section 2.7 of the *Recovery Strategy for the Eastern Sand Darter (Ammocrypta pellucida) in Canada: Ontario populations* (DFO 2012); and Section 2.7 of the *Recovery Strategy for the Northern Madtom (Noturus stigmosus) in Canada* (Edwards *et al.* 2012). These recovery strategies contain species-specific details about the identified critical habitat, including geospatial extent and biophysical functions, features and attributes.

The geographic extent of critical habitat within the Sydenham River watershed for the fish and mussel species at risk is summarized below to provide context for recovery actions only; for greater detail please refer to the relevant sections of the applicable recovery strategies.

For six of the seven freshwater mussels, the extent of critical habitat is found within the East Sydenham River, from a point approximately 8 km southwest of Strathroy downstream to Dresden. Also included are short sections of the mouths of three tributaries (i.e., Spring, Brown and Fansher creeks). In the case of the Round Hickorynut, the extent of critical habitat includes these areas as well as the reach of the lower East Sydenham from Dresden to the mouth of the river at Chenal Ecarte. Additional areas of critical habitat for the Round Pigtoe are found in the North Sydenham within the reaches of Bear Creek, upstream of Petrolia.

The extent of critical habitat for the Eastern Sand Darter includes the East Sydenham River from Strathroy to the Chenal Ecarte (DFO 2012), thus overlapping critical habitat identified for the freshwater mussels. For the Northern Madtom, critical habitat has not been identified yet within the Sydenham River watershed because only two historical records exist for this species within the East Sydenham River (Edwards *et al.* 2012). Further studies will be conducted to determine the extent of its critical habitat, if any, in the East Sydenham River.

Areas within which critical habitat may be found in the Sydenham River watershed for the seven freshwater mussels and the Eastern Sand Darter are illustrated in Figure 2.

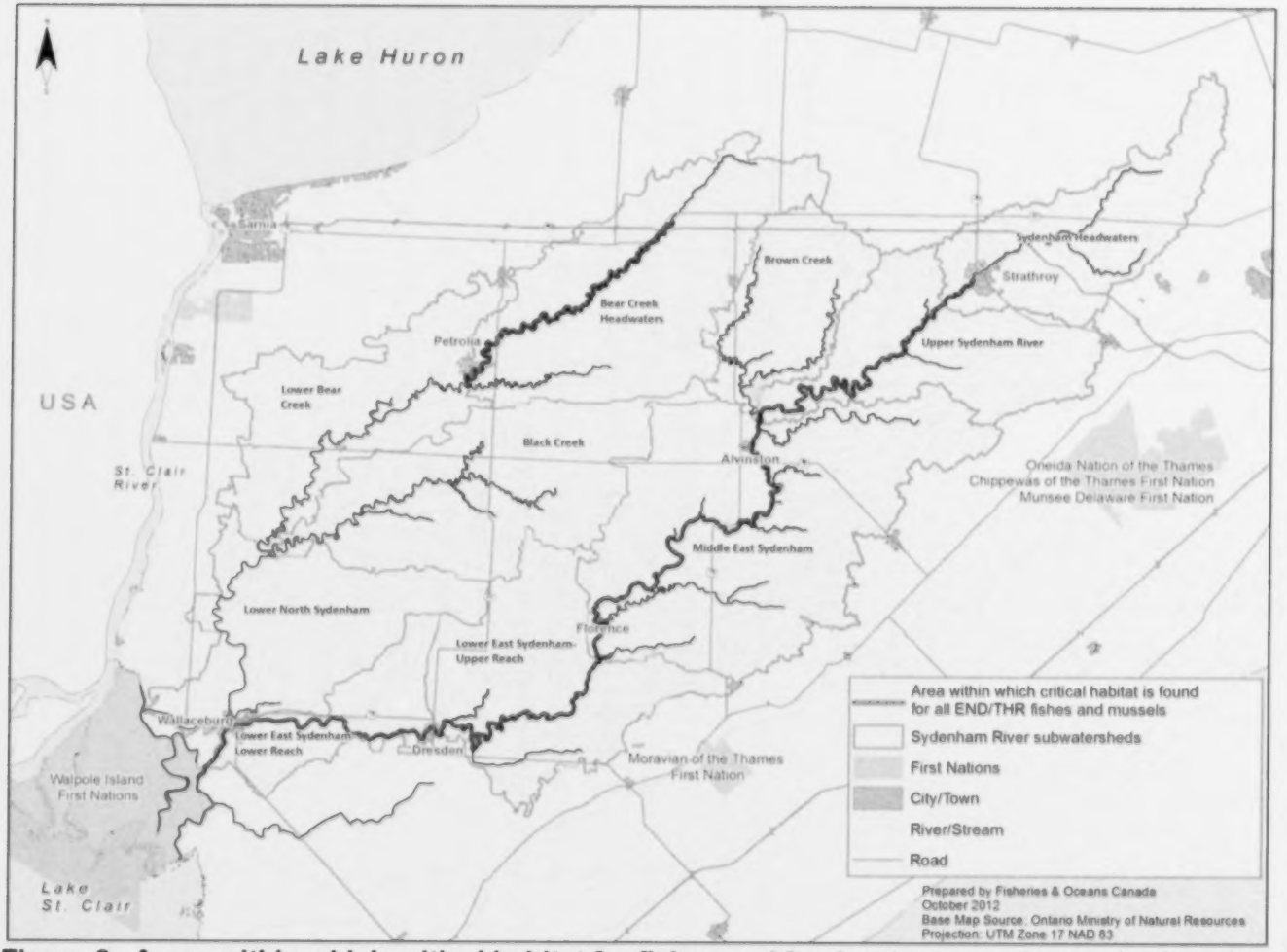

Figure 2. Areas within which critical habitat for fishes and freshwater mussels may be found in the Sydenham River watershed. To be used for illustrative purposes only – for more detail refer to relevant recovery strategies.

4.1.2 Examples of activities likely to result in destruction of critical habitat

The following is a summary of examples of human activities likely to result in the destruction of critical habitat for species at risk fishes and/or mussels in the Sydenham River watershed:

- Work in or around water with improper sediment and erosion control
- Unfettered livestock access to waterbodies
- Removal or cultivation of riparian vegetation
- Over-application of fertilizer and improper nutrient management
- Introduction of high levels of chloride through excessive salting of roads in winter
- Water-level management or water extraction activities that causes dewatering of habitat or excessive flow rates
- Direct removal of host fishes (through harvest) or removal by indirect means
- Over application or misuse of herbicides and pesticides
- Grading, dredging or excavation
- Placement of material or structures in water
- Construction of dams and/or barriers
- Use of motor vehicles in the river (e.g. ATVs)

More detailed information regarding activities likely to result in the destruction of critical habitat for the seven freshwater mussels and the Eastern Sand Darter may be found in their respective recovery strategies: Section 7.6 of the *Recovery Strategy for the Round Hickorynut (Obovaria subrotunda) and the Kidneyshell (Ptychobranchus fasciolaris) in Canada* (DFO 2013a); Section 2.6.6 of the *Recovery Strategy for Northern Riffleshell, Snuffbox, Round Pigtoe, Salamander Mussel and Rayed Bean* (DFO 2018); and Section 2.7.6 of the *Recovery Strategy for the Eastern Sand Darter (Ammocrypta pellucida) in Canada: Ontario populations* (DFO 2012).

4.2 Proposed measures to protect critical habitat

Under SARA, critical habitat must be legally protected from destruction within 180 days of being identified in a recovery strategy or action plan. For the seven freshwater mussels and the Eastern Sand Darter's critical habitat, it is anticipated that this will be accomplished through SARA Critical Habitat Orders made under subsections 58(4) and (5), which will prohibit the destruction of the identified critical habitat.

4.3 Focusing stewardship prioritization

To increase the probability of successful mitigation of threats within the 2725 km^2 watershed, stewardship activities should be concentrated where they most benefit populations of the Endangered and Threatened fish and mussel species at risk listed under SARA. Extant populations of eight of the nine species at risk (all but Northern Madtom) are known within the reaches of the East Sydenham from Strathroy (upper sub-watershed) downstream to Dresden (lower sub-watershed); this section of the

watershed includes the majority of critical habitat identified for these species and is considered the 'conservation priority zone' by the recovery team (Figure 3). Only the Round Pigtoe has been found at one location within the Bear Creek headwaters where suitable habitat appears limited.

The sub-watersheds that contain and support the conservation priority zone are considered the priority area for targeted mitigation activities (Figure 3). Stewardship efforts should be prioritized to address the greatest threats (high and medium level of concern) with the highest probability of successful mitigation, which includes addressing loadings of nutrients and suspended solids from overland runoff and livestock, nutrient loads from municipal sewages, ammonia from overland runoff of manure, and thermal effects from loss of riparian buffers in agricultural and urban catchments.

As sediment and nutrient inputs from agricultural practices tend to be non-point source, stewardship actions should be targeted within the five priority sub-basins of the East Sydenham River. These stewardship actions, including Best Management Practices, should be encouraged through outreach and education, and stewardship grants. Further details are included within the Implementation Schedule (Table 6).

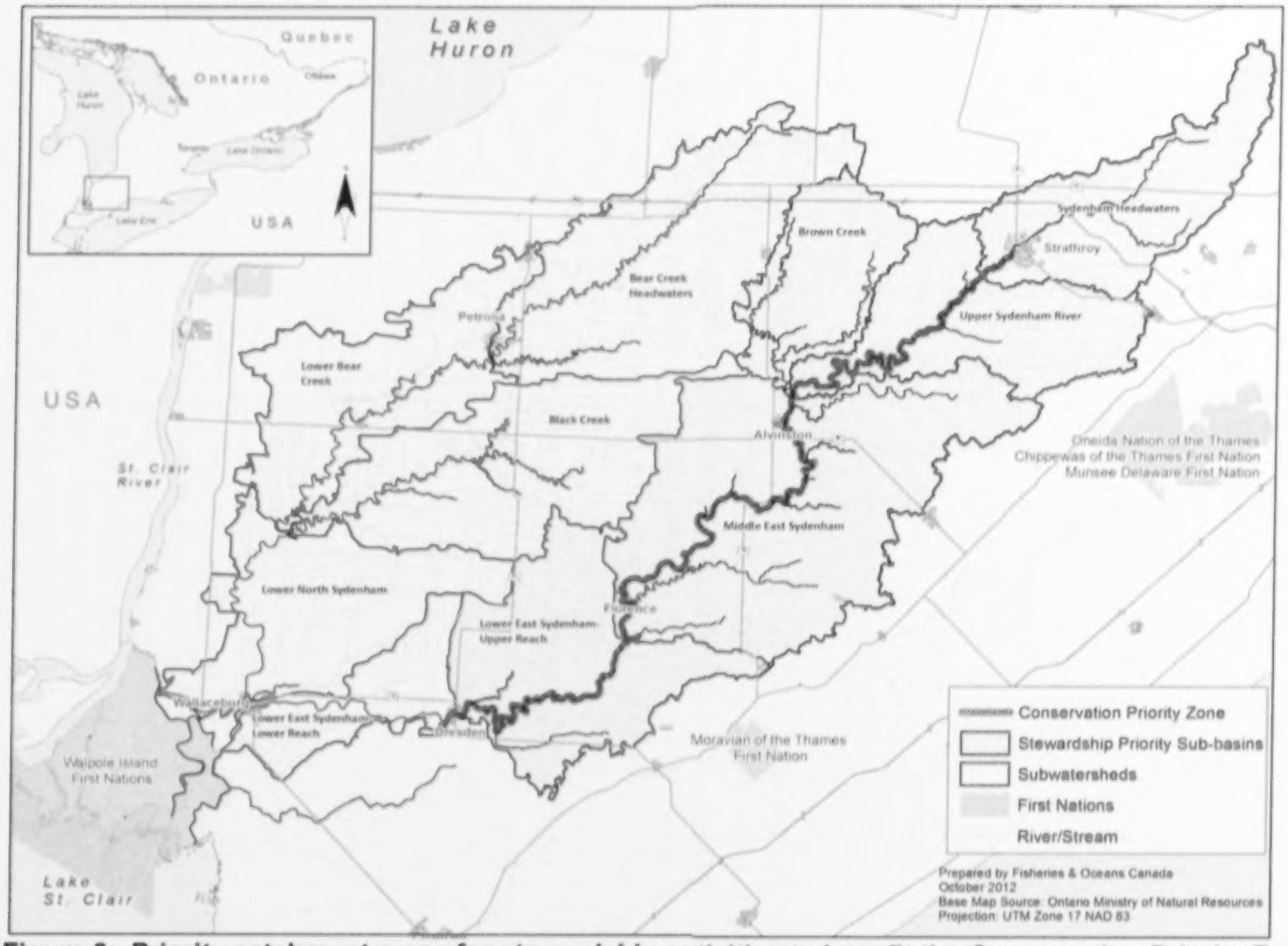

Figure 3. Priority catchment areas for stewardship activities to benefit the Conservation Priority Zone.

4.4 Measures Underway

Measures underway to address threats include stewardship actions by landowners involving Best Management Practices for agricultural properties (Agriculture Canada and OMAFRA 1992 – 2011) and residential properties (School of Environmental Design and Rural Development 2007) within the catchment area of the critical habitat identified for fishes and freshwater mussels.

Voluntary stewardship activities have already been undertaken toward reducing sediment and nutrient inputs throughout the Sydenham River watershed; this has occurred since 2001 when the Sydenham River Stewardship Initiative was established. Riparian vegetation has been planted at many sites to reduce streamside erosion and sediment inputs. In some cases, stream banks have been stabilized to reduce erosion, riparian zones have been preserved or improved, shorelines have been fenced to restrict livestock from watercourses, manure storage facilities have been upgraded to reduce nutrient runoff, and septic systems have been upgraded, thus protecting nearby watercourses.

To encourage further stewardship efforts, an active outreach program exists providing:

- direct landowner contact;
- a dedicated website (Sydenham River watershed - helping species at risk);
- displays at community events;
- riverbank signage posted in areas identified as critical habitat (at access points);
- presentations at public meetings and to non-governmental interest groups of farmers, naturalists or community groups;
- demonstration projects that profile several pasturing options designed to keep cattle out of streams (e.g., solar-powered water pumps for pasture cattle, rotational grazing, low level stream crossings);
- an education program for school-aged children;
- presentations and displays on the Sydenham Recovery Program at watershed community events; and,
- an annual newsletter distributed through all watershed newspapers, describing recent research, current stewardship, outreach and education activities and encouraging further voluntary stewardship.

4.5 Measures to be taken and implementation schedule

Success in the recovery of the freshwater mussels and fishes of the Sydenham River is not solely dependent on the actions of any single jurisdiction; rather it requires the commitment and cooperation of many different constituencies that will be involved in implementing the directions and actions set out in this action plan.

The purpose of this action plan is to outline what needs to be done to achieve the population and distribution objectives for the nine aquatic species at risk within the Sydenham River watershed. As such, the action plan will guide not only activities to be undertaken by Fisheries and Oceans Canada, but also those actions for which other jurisdictions, organizations and individuals have a role to play. Fisheries and Oceans Canada and the Sydenham River Recovery Team strongly encourage all Canadians to participate in the conservation of these species through undertaking priority recovery measures outlined in this action plan. In addition, where appropriate, Fisheries and Oceans Canada seeks to engage with organizations or individuals and enter into a Conservation Agreement under section 11 of SARA to implement the relevant conservation measures.

Table 5 identifies the recovery measures to be facilitated or led by Fisheries and Oceans Canada, in cooperation and consultation with other agencies, organizations and individuals (e.g., members of the Sydenham River Recovery Team) as appropriate, to support the recovery of freshwater mussels and fishes in the Sydenham River watershed. As all Canadians are invited to join in supporting and implementing this action plan for the benefit of these species and Canadian society as a whole, Table 6 identifies measures that could be undertaken voluntarily by other jurisdictions, groups and individuals interested in participating in the recovery of these species. If your organization is interested in participating in one of these measures, please contact the Species at Risk - Central and Arctic office at fwisar@dfo-mpo.gc.ca.

Implementation of this action plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations. Note that further details relating to individual recovery actions in the following implementation tables may be found within the relevant fish and mussel recovery strategies (refer to table 2).

Table 5. Implementation schedule: measures to be led by Fisheries and Oceans Canada*.

#	Recovery Measures	Priority[2]	Threats or Concerns Addressed	Timeline
Broad Strategy: Research and Monitoring				
	Approach: Background Surveys – Northern Madtom (NMT) and Eastern Sand Darter (ESD).			
1	Background Surveys – Northern Madtom** a) Conduct targeted sampling in areas of historically occupied habitat (river reaches in the vicinity of Florence and Alvinston) as well as other potentially suitable habitats. Use sampling techniques proven to detect NMT (e.g., night/day seining and trawling).	**High**	Will determine presence/absence of the NMT within the East Sydenham River. If an extant population is confirmed, will determine health, range, abundance and population demographics and contribute to the identification of critical habitat.	2018-2020
2	Background Surveys – Eastern Sand Darter** Conduct additional sampling in the Lower North Sydenham (e.g., trawling) and in upper watershed in the region of Shetland (approximately 5 km downstream of Alvinston).	**Medium**	Will determine health, range, abundance and population demographics of the Sydenham River population.	2018-2020

[2] "Priority" reflects the degree to which the measure contributes directly to the recovery of the species or is an essential precursor to a measure that contributes to the recovery of the species. High priority measures are considered those most likely to have an immediate and/or direct influence on attaining the recovery objective for species. Medium priority measures may have a less immediate or less direct influence on reaching the recovery population and distribution objectives, but are still important for recovery of the population. Low priority recovery measures will likely have an indirect or gradual influence on reaching the recovery objectives, but are considered important contributions to the knowledge base and/or public involvement and acceptance of species.

#	Recovery Measures	Priority[2]	Threats or Concerns Addressed	Timeline
	Approach: Determine/confirm functional host fishes and their distributions and abundances (all mussels).			
3	Research host fish a) Continue host fish testing and juvenile propagation for all at-risk freshwater mussels in the laboratory and confirm functional host species used in the Sydenham River watershed. Investigate the use of molecular methods to confirm functional host relationships (e.g, genetic analysis of glochidia from appropriately preserved gill or fin tissues from fish specimens taken from the Sydenham River watershed). b) Determine the distribution and abundance of the host species and evaluate if current host populations are sufficient to support recovery objectives for SAR mussels; if this is not the case, additional management actions may be required to expand or increase the populations of the host species.**	**High**	Will help determine if host abundance is limiting factor for these seven mussel species. If required, background data will be available to develop additional actions for the management of host species. Will assist with identifying critical habitat.	2018-2020
	Approach: Develop guidelines on the feasibility of relocations, reintroductions and the establishment of managed refuge sites.			
4	Population augmentation - Mussels a) Develop science-based guidelines on the feasibility of translocations and repatriations, to determine if small populations can be augmented or if the species can be reintroduced in historical range. This work would recognize the American Fisheries Society Guidelines for Propagation and Translocation for Freshwater Fish Conservation (George *et al.* 2009) as well as the National Code on Introductions and Transfers of Aquatic Organisms.	**Medium**	Must consider all underlying issues to translocation and introduction of mussels, for donor and recipient populations.	2019-2021

#	Recovery Measures	Priority[2]	Threats or Concerns Addressed	Timeline
Approach: Long-term monitoring program for all species at risk mussels and fish and their habitat.				
5	Monitoring mussel and host fish populations and their habitat a) Resample permanent monitoring stations (Metcalfe-Smith *et al.* 2007) throughout historical and present ranges of species at risk mussels to permit tracking of populations, analysis of trend patterns, and permit the evaluation of recovery actions. Maintain a standardized index population and habitat monitoring program. b) Establish permanent monitoring program for tracking changes in habitat. Incorporate current water quality and quantity monitoring as well as invertebrate sampling.	**High (all mussels)**	Will provide a measure of species' security. Will ensure that the most effective recovery actions are given priority over less effective actions. Provides trend data for key habitat and will help evaluate the relative threat of habitat loss.	2018-2021
6	Monitoring - Eastern Sand Darter populations and habitat** a) Establish a network of permanent monitoring stations throughout historical and present ranges to permit tracking of populations, analysis of trend patterns, and permit the evaluation of recovery actions. Establish and implement a standardized index population and habitat monitoring program. The monitoring program will provide insight into the significance of threat factors including potential impacts of the Round Goby.	**High**	Will provide a measure of species' security. Will provide insight into threat factors (e.g., expansion of Round Goby populations). Will ensure that the most effective recovery actions are given priority over less effective actions.	2018-2020
Approach: Confirm/identify threats, evaluate their relative importance and implement remedial actions to minimize their impacts.				
7	Research threats a) Investigate the mechanisms of impact of Round Goby on all SAR mussels and fishes. Monitor distribution of Round Goby in areas important to SAR populations.**	**High (all fish and mussel SAR)**	Will identify the degree to which Round Goby may impact SAR fishes and mussels.	2019-2021

#	Recovery Measures	Priority[2]	Threats or Concerns Addressed	Timeline
Broad Strategy: Management				
	Approach: Encourage the development of expertise in freshwater mussel identification/biology, and encourage/coordinate actions to reduce harmful impacts upon mussels and mussel habitat among government and non-government entities.			
8	Capacity building a) Continue to promote and enhance expertise in freshwater mussel identification/biology (e.g. DFO's mussel identification course) and provide for the transfer of knowledge.	**High (all mussel species)**	Will ensure correct identification of mussel species at risk, and maintenance of institutional knowledge of habitat/ecology.	Ongoing
9	Integration of recovery actions across relevant recovery teams a) Work with existing recovery teams to implement recovery actions as needed.	**High (all SAR)**	Ensure a seamless implementation of all recovery actions across jurisdictions.	Ongoing
	Approach: Evaluation of watershed-scale stressors.			
10	Habitat management and strategy a) Ensure planning and management agencies recognize the importance of fluvial processes and sources of sand bedload in the maintenance of Eastern Sand Darter habitats. b) Ensure that flow requirements of all species at risk mussels and their hosts are considered in the management of water supply and flow regimes.	**Medium**	Will result in protection of important habitat from development activities, and identify multiple stressors that may affect populations. Will ensure the flow requirements of species at risk are met. Would support the removal of obsolete dams.	2018-2023
11	a) Evaluate the impacts and relative importance of watershed-scale stressors to SAR populations and their habitats (including exotic species).	**High**	Will identify multiple stressors that may affect SAR populations.	2018-2020

#	Recovery Measures	Priority[2]	Threats or Concerns Addressed	Timeline
Broad Strategy: Outreach and Awareness				
Approach: Increase awareness about the distribution, threats and recovery of these species (ALL SAR).				
12	Awareness of critical habitat a. Increase industry knowledge of critical habitat, and potential impacts from industrial products (e.g. petroleum spills) and their transportation on these features. b. Hold one-day workshops with municipal staff and planning and review agencies. c. Increase awareness of the presence of and need to protect critical habitat among landowners and those accessing the river corridor for recreation. This will help reduce the need for enforcement actions against disruptive activities such as driving motor vehicles or ATV's in the river.	**Medium**	Will increase industry awareness as well as planning and review agency staff of critical habitat within the Sydenham River. Will promote protection and/or mitigation of habitat from various threats (including impacts from vehicles and ATVs driving in the river).	2018-2020

* Many of the measures outlined in this table may be implemented in partnership with other agencies represented on the recovery team (e.g. SCRCA, MNRF and University of Guelph).

** Measures that relate to the sampling of fish populations; where possible, these activities should be conducted in a coordinated fashion using sampling methodologies that ensure maximum benefit to multiple species (including those covered by management plans: Edwards and Staton 2009; Beauchamp *et al.* 2012).

Table 6. Implementation Schedule: measures that could be taken voluntarily by other agencies, organizations or individuals who wish to contribute to the recovery of freshwater mussels and fishes in the Sydenham River.

#	Recovery Measures	Priority[3]	Threats or Concerns Addressed	Timeline	Partner Agency †
Broad Strategy: Management					
	Approach: Encourage the development of expertise in freshwater mussel identification/biology, and encourage/coordinate actions to reduce harmful impacts upon mussels and mussel habitat among government and non-government entities.				
1	Wastewater treatment plants and stormwater management facilities a) Evaluate whether existing wastewater treatment plants (e.g., Strathroy, Alvinston, Dresden and Wallaceburg) are functioning to specifications and encourage upgrading where appropriate. Where possible, quantify overflows. b) Review stormwater management facilities for quantity and quality control in new developments, and retro-fit existing development where possible.	**Medium (all mussels)**	Will improve water quality by reducing nutrient and suspended solid inputs from urban centres.	2018-2019	MOE
	Approach: Develop protocol to respond to spills.				
2	a) Meet with staff from the MOE Spills Action Centre to explain the significance of the river and its SAR; provide SAR contact information for Sydenham River watercourses. b) Develop protocol to respond to reported spills to monitor and mitigate impacts to SAR fish and mussels.	**High**	Will improve protection of aquatic SAR in affected watersheds.	2018-2020	MOE with recovery team support

[3] "Priority" reflects the degree to which the measure contributes directly to the recovery of the species or is an essential precursor to a measure that contributes to the recovery of the species. High priority measures are considered those most likely to have an immediate and/or direct influence on attaining the recovery objective for species. Medium priority measures may have a less immediate or less direct influence on reaching the recovery population and distribution objectives, but are still important for recovery of the population. Low priority recovery measures will likely have an indirect or gradual influence on reaching the recovery objectives, but are considered important contributions to the knowledge base and/or public involvement and acceptance of species.

#	Recovery Measures	Priority[3]	Threats or Concerns Addressed	Timeline	Partner Agency †
Broad Strategy: Stewardship & Habitat Improvement					
	Approach: Encouraging Best Management Practices (BMPs) to help reduce the impacts of terrestrial activities on aquatic ecosystems, through increasing awareness of these activities as well as through the provision of financial assistance to local landowners (ALL SAR). *The following BMPs and stewardship activities will be directed to stewardship priority sub-basins only (refer to Figure 3).*				
3	Riparian buffers a) Establish riparian buffer zones (ideally 30 m in width or greater) in areas of high erosion potential by encouraging naturalization or planting of native species. Will improve water quality by increasing shade and reducing bank erosion, sedimentation and overland run-off. Care must be taken not to impact important nesting beaches for the Eastern Spiny Softshell (SARA status – Threatened) when working in the riparian zone.	**High**	Will improve water and habitat quality by reducing siltation and turbidity, nutrient loads, toxic compounds, and thermal effects.	Ongoing	SCRCA + Stewardship Councils
4	Tile drainage a) Work with landowners to mitigate the effects of tile drainage and agricultural drains to reduce nutrient and sediment inputs. Pilot and demonstration projects may be a necessary first step.	**High**	Will improve water quantity and quality by reducing nutrient and sediment inputs.	Ongoing	SCRCA + Stewardship Councils
5	Herd management a) Encourage the active exclusion of livestock from the watercourse (e.g. by fencing) to reduce bank erosion and nutrient and sediment inputs.	**High**	Will improve water quality by reducing nutrient and sediment inputs.	Ongoing	SCRCA + Stewardship Councils
6	Wetland protection, enhancement and restoration a) Prioritize locations for enhancing or re-establishing wetlands in appropriate locations. b) Assist with protection of existing wetlands through various means (including acquisition if warranted). c) Assist with enhancement or restoration of wetlands.	**High**	Will improve water quantity and quality by contributing to low flow augmentation, groundwater recharge and sediment/nutrient control.	Ongoing	SCRCA + Stewardship Councils

#	Recovery Measures	Priority[3]	Threats or Concerns Addressed	Timeline	Partner Agency †
7	Livestock waste management a) Assist with establishing adequate manure collection and storage systems to avoid accidental spills and winter-spreading of manure, to reduce nutrient inputs (for consistency with the policies of the *Canada-Ontario Farm Stewardship Program*).	**Medium**	Will improve water quality by reducing nutrient loads.	Ongoing	SCRCA + Stewardship Councils
8	Farm planning a) Encourage the development and implementation of Environmental Farm Plans and Nutrient Management Plans to minimize nutrient and sediment inputs. In some cases, such plans are required for landowner eligibility for stewardship funds.	**Medium**	Will improve water quality by reducing nutrient and sediment inputs.	Ongoing	SCRCA + Stewardship Councils
9	Sewage treatment (rural) a) Work with landowners to improve faulty septic systems to reduce nutrient inputs.	**Medium**	Will improve water quality by reducing nutrient inputs.	Ongoing	SCRCA + Stewardship Councils
10	Agency interaction a) Cooperating and coordinating efforts with stewardship councils and SCRCA to improve the implementation of stewardship activities and leverage additional funding.	**Medium**	Will improve the implementation of stewardship activities.	Ongoing	SCRCA + Stewardship Councils (and other partners such as DU)

#	Recovery Measures	Priority[3]	Threats or Concerns Addressed	Timeline	Partner Agency †
Broad Strategy: Outreach and Awareness					
	Approach: Increase awareness about the distribution, threats and recovery of these species (ALL SAR).				
11	Awareness of stewardship opportunities and critical habitat a) Increase public knowledge of critical habitat, stewardship options and financial assistance available to participate in activities (e.g., watershed newsletter distributed annually by SCRCA).	**High**	Will increase public participation in recovery actions and a reduction in all threats.	Ongoing	SCRCA + Stewardship Councils
12	Exotic species a) Increase public awareness of the potential impacts of transporting/releasing exotic species as well as the importance of identifying and reporting them. Encourage use of the Ontario Federation of Anglers and Hunters (OFAH) invading species hotline and DFO's Baitfish Primer.	**High**	Will reduce the risk of exotic species becoming established in new locations (e.g., dreissenid mussels and Round Goby).	Ongoing	MNRF (and OFAH)
13	Outreach a) Encourage public support and participation by developing awareness materials such as an annual newsletter, posters, website, riverbank signage and displays, and programs for schools, public interest groups, First Nations groups, agencies, and other interested stakeholders regarding SAR mussels and fishes of the Sydenham River.	**Medium**	Will increase public awareness of the importance of species at risk and a reduction in all threats.	Ongoing	SCRCA + MNRF

† Acronyms:
DU – Ducks Unlimited
MOE – Ministry of the Environment
MNRF – Ontario Ministry of Natural Resources and Forestry
OFAH – Ontario Federation of Anglers and Hunters
SCRCA – St. Clair Region Conservation Authority

5. Evaluation of socio-economic costs and benefits

The *Species At Risk Act* requires that an action plan include an evaluation of the socio-economic costs of the action plan and the benefits to be derived from its implementation (SARA 49(1)(e), 2003). This evaluation addresses only the incremental socio-economic costs of implementing this action plan from a national perspective as well as the social and environmental benefits that would occur if the action plan were implemented in its entirety, recognizing that not all aspects of its implementation are under the jurisdiction of the federal government. It does not address cumulative costs of species recovery in general nor does it attempt a cost-benefit analysis. Its intent is to inform the public and to guide decision making on implementation of the action plan by partners.

The protection and recovery of species at risk can result in both benefits and costs. The Act recognizes that "*wildlife, in all its forms, has value in and of itself and is valued by Canadians for aesthetic, cultural, spiritual, recreational, educational, historical, economic, medical, ecological and scientific reasons*" (SARA 2003). Self-sustaining and healthy ecosystems with their various elements in place, including species at risk, contribute positively to the livelihoods and the quality of life of all Canadians. A review of the literature confirms that Canadians value the preservation and conservation of species in and of themselves. Actions taken to preserve a species, such as habitat protection and restoration, are also valued. In addition, the more an action contributes to the recovery of a species, the higher the value the public places on such actions (Loomis and White 1996; DFO 2008). Furthermore, the conservation of species at risk is an important component of the Government of Canada's commitment to conserving biological diversity under the *International Convention on Biological Diversity*. The Government of Canada has also made a commitment to protect and recover species at risk through the *Accord for the Protection of Species at Risk*. The specific costs and benefits associated with this action plan are described below. The evaluation describes, to the extent possible, the benefits that may accrue, as well as the costs that governments, industry and/or Canadians may incur due to activities identified in this action plan.

This evaluation does not address the socio-economic impacts of protecting critical habitat for all of the species represented in this action plan. Under SARA, DFO must ensure that critical habitat identified in a recovery strategy or action plan is legally protected within 180 days of the final posting of the recovery strategy or action plan. Where a SARA Order will be used for critical habitat protection, the development of the Order will follow a regulatory process in compliance with the Cabinet Directive on Streamlining Regulations (CDSR), including an analysis of any potential incremental impacts of the SARA Order that will be included in the Regulatory Impact Analysis Statement. As a consequence, no additional analysis of the critical habitat protection has been undertaken for the assessment of costs and benefits of the action plan.

Baseline

This evaluation addresses the costs and benefits that would be anticipated to occur if the action plan is fully implemented. The analysis only considers costs and benefits

which are incremental to the baseline (e.g., costs/benefits associated with new activities or enhancements to existing activities that are above-and-beyond what is part of current practice or formal commitments).

All the species represented in this action plan are listed and protected under the *Species at Risk Act*, as well as being afforded protection under Ontario's *Endangered Species Act, 2007*. Other legislation that may already provide direct or indirect habitat protection for these species include existing provincial legislation[4] and the federal *Fisheries Act*. The baseline also includes the recovery actions that were implemented prior[5] to and after the species were listed under SARA.

These recovery actions included various projects[6] funded by the Government of Canada's Habitat Stewardship Program for Species at Risk, partnering with the province of Ontario, universities, county stewardships groups, the St Clair Region Conservation Authority as well as agricultural and non-farm rural landowners within the watershed. In addition, several research and monitoring projects to support the recovery of SARA-listed fishes and freshwater mussels in the Sydenham River have been funded directly by Fisheries and Oceans Canada in support of the Sydenham River Recovery Strategy (Dextrase *et al.* 2003).

Socio-economic profile
In the Sydenham River basin, approximately 85% of the land base is currently used for agricultural activities. There are also some urban and industrial activities within the basin.

Socio-economic benefits of implementing this action plan
Some of the benefits of recovery actions required to return/maintain self-sustaining populations of the nine species outlined in this action plan are difficult to quantify but would generally be positive. Beyond some of the unquantifiable non-market benefits mentioned in the second paragraph of this evaluation, the recovery actions are also likely to provide broader benefits for Canadians (e.g., enhanced water quality).

Additionally, eight other at risk mussels and fishes (not specifically addressed by this action plan) will benefit from the recovery actions proposed for the nine priority species through the overall improvement to shared aquatic habitats. Where SARA management plans exist for Special Concern fishes such as Blackstripe Topminnow, Pugnose Minnow, Spotted Sucker and Grass Pickerel, this action plan will help to support many of the management actions required for these species. Semi-aquatic species at risk (i.e. turtles and dragonflies) are also expected to benefit from this plan but are not specifically addressed. Many of the stewardship actions proposed (such as the establishment of riparian buffers and improved livestock management) will also result in

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[4] Examples of other provincial legislation that provide habitat protection include considerations under Section 3 of Ontario's *Planning Act* which prohibits development and site alteration in the significant habitat of endangered species and protection under the *Lakes and Rivers Improvement Act* in Ontario.

[5] Recovery actions implemented under the *Recovery Strategy for Species at Risk in the Sydenham River: An Ecosystem Approach* (Dextrase *et al.* 2003) have been ongoing since 2002, thus predating SARA.

[6] Projects include stewardship and management actions, community awareness and outreach activities.

improved terrestrial habitat for upland wildlife; in some cases improved hunting opportunities may result.

Recovery actions that help to enhance water quality, through best management practices[7], will contribute to improved downstream drinking water quality. Improved water quality will lead to healthier ecosystems, which, in turn, support healthier fisheries. This is expected to result in improved recreational fishing opportunities in the Sydenham River (e.g., for Walleye, Smallmouth Bass and other sport fishes) as well as healthier fisheries downstream in the waters of the Great Lakes (for example the Sydenham River is a major contributor of sediment and nutrients to Lake St. Clair).

Recovery actions to improve aquatic habitats, in the form of voluntary best management practices[8], are developed and promoted by agricultural groups as cost-effective ways to conserve a farm's soil and water resources (OMAFRA 2012). There is a positive impact to agricultural producers' sustainability as soil and water quality can be improved through the use of best management practices.

Socio-economic costs of implementing this action plan

The majority of the recovery activities identified in this action plan are on-going or short-term (2015-2020). It should be noted that an ecosystem-based action plan that addresses multiple species is a more cost-effective approach than multiple, single-species implementation approaches. An ecosystem or watershed approach also addresses 'issues of scale', recognizing that threats often originate across the landscape in upstream areas of the watershed and prescribes appropriate and more strategic solutions than could be accomplished with a single-species focus.

Most of these activities focus on stewardship (e.g., promotion and support of best management practices), research, monitoring, assessment, engagement, education, and management to reduce threats and to improve species recovery. Some of the actions are one-time projects (e.g., research and monitoring), possibly funded from existing federal government resources or annual funding programs such as the Habitat Stewardship Program. In addition, most programs require a level of direct or in-kind support costs from applicants as matching funds[9]. The costs (direct and in-kind) associated with these short-term actions are estimated to be low[10] and spread over the next five years[11].

Costs would be incurred by the federal government to implement the activities listed in the Action Plan. In-kind costs such as volunteer time, providing expertise and

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[7] Best management practices consist of actions to reduce the amount of nutrient and sediment inputs that are in the water. Examples of such actions include improving sewage treatment, environmentally friendly farming practices and establishing riparian buffers.

[8] Examples of best management practices for agricultural producers include the establishment of riparian buffers (to reduce the amount of nutrient and sediment inputs into the water), livestock waste management, and wetland restoration and enhancement.

[9] For example, matching funds for the Habitat Stewardship Program are often provided by landowners and/or provincial funding programs. This helps leverage additional support for recovery actions.

[10] Low costs are defined as less than $1 million annually.

[11] Future expenditures cannot be determined in great detail as it is expected these activities could continue to be funded through existing annually funded government programs (e.g. Habitat Stewardship Program), where support is determined on a priority basis and based on availability of resources.

equipment would be incurred as a result of implementing activities listed in the Action Plan. Costs (including in-kind support) could be incurred by the province of Ontario, stewardship councils and conservation authorities. Some agricultural and non-farm land owners within the Sydenham River watershed may incur some costs for best management practices. However, as many of the activities and actions are of a collaborative and voluntary nature, agricultural and non-farm land owners are likely to only incur costs on a voluntary[12] basis.

Long-term recovery activities will be developed through a cooperative approach following discussions between other agencies, levels of government, stewardship groups and stakeholders allowing for consideration of costs and benefits during the process. While long-term costs are estimated to be low, it is recognized that greater levels of funding would be required to achieve the recovery goals of the action plan within a shorter time frame.

Distributional impacts
Governments, the St Clair Region Conservation Authority and county stewardship councils will incur the majority of costs of implementing the action plan.

The Canadian public will benefit from the implementation of the action plan through the likely improvement in water quality, enhanced fisheries[13] and wildlife as well as increased wildlife hunting opportunities. The implementation of best management practices by agricultural land owners should help to improve the sustainability of their operations.

6. Measuring progress

The performance indicators presented in the associated recovery strategies provide a way to define and measure progress toward achieving the population and distribution objectives relevant to the Sydenham River watershed:

- *Recovery Strategy for the Round Hickorynut (Obovaria subrotunda) and the Kidneyshell (Ptychobranchus fasciolaris) in Canada* (DFO 2013a) – Section 2.5;
- *Recovery Strategy for Northern Riffleshell, Snuffbox, Round Pigtoe, Salamander Mussel and Rayed Bean* (DFO 2018) – Section 2.5;
- *Recovery Strategy for the Eastern Sand Darter (Ammocrypta pellucida) in Canada: Ontario populations* (DFO 2012) – Section 2.6; and,
- *Recovery Strategy for the Northern Madtom* (*Noturus stigmosus*) in Canada (Edwards *et al.* 2012) – Section 2.6.

Monitoring measures are also included in the action plan to monitor the recovery of the species and their long term viability (refer to implementation schedule - table 5, actions 5 and 6). Reporting on implementation of the action plan, under s. 55 of SARA, will be

[12] Costs to be compliant with listing or Critical Habitat Order prohibitions and requirements are assessed elsewhere.

[13] Improvements to water quality and enhanced fisheries would be due to the adoption and implementation of the best management practices previously mentioned in this evaluation.

done by assessing progress towards achieving the broad strategies/recovery objectives as they relate to recovery measures taken within the Sydenham River watershed. Reporting on the ecological and socio-economic impacts of the action plan, under s. 55 of SARA, will be done by assessing the results of monitoring the recovery of the species and their long term viability, and by assessing the implementation of the action plan.

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Appendix A: Effects on the environment and other species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery plan could affect any component of the environment or achievement of any of the Federal Sustainable Development Strategy's (FSDS) goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that implementation of action plans may inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the action plan itself, but are also summarized below in this statement.

The Sydenham River Action Plan takes an ecosystem approach in addressing predominant threats in the watershed in an effort to restore and improve aquatic habitat for species at risk mussels and fishes (targeting SARA-listed species, but providing benefit to non-listed SAR as well). By improving water and habitat quality in the system for some of the most sensitive aquatic organisms, habitat improvements will benefit biodiversity in general and help restore balance to the natural community. Work in the riparian areas will be conducted in such a way that it does not interfere with habitats and management of semi-aquatic and terrestrial species at risk. In most cases, riparian restoration will benefit terrestrial wildlife and plant species. Where possible, efforts with the Sydenham River Action Plan will be combined with terrestrial efforts by stewardship practitioners as has been done in the past with the Sydenham River Stewardship Initiative.